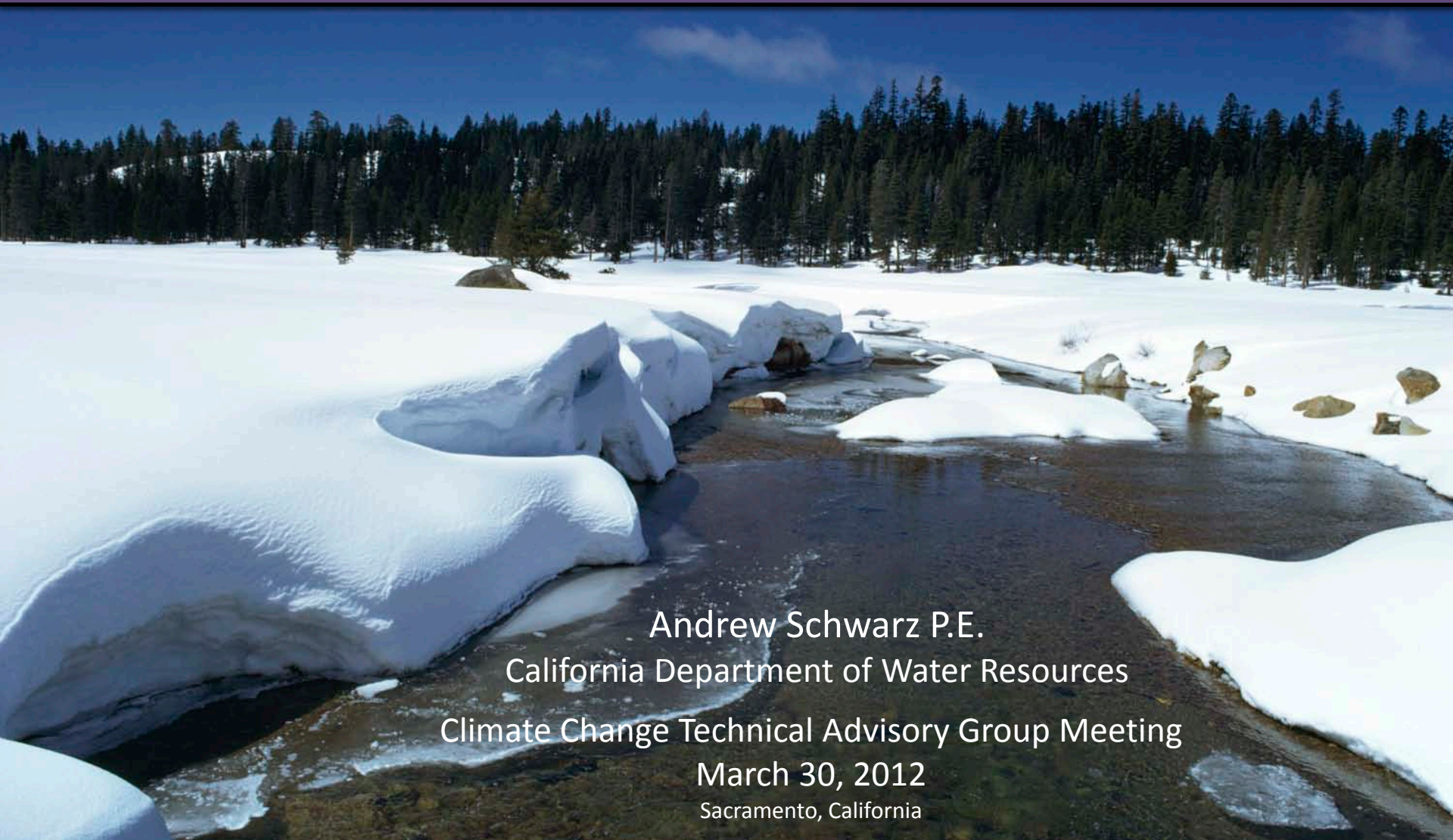




# Past DWR Studies and CCTAG Initial Scope of Work



Andrew Schwarz P.E.  
California Department of Water Resources  
Climate Change Technical Advisory Group Meeting  
March 30, 2012  
Sacramento, California

# Selected DWR responsibilities that use climate change information

## Water Plan

Rich Juricich  
juricich@water.ca.gov

## Flood Management

Mike Anderson  
manderso@water.ca.gov

## Water Supply

Francis Chung  
chung@water.ca.gov

## Delta

Jamie Anderson  
jamiea@water.ca.gov

## Environmental Impacts Assessment

Andrew Schwarz  
aschwarz@water.ca.gov

## Integrated Water Resources Management

Kamyar Guivetchi  
kamyarg@water.ca.gov

## Climate Change

John Andrew jandrew@water.ca.gov  
Elissa Lynn elynn@water.ca.gov

# DWR Planning Studies

## General Planning Studies

### Water Plan

Rich Juricich  
juricich@water.ca.gov

## Project Level Studies

### Environmental Impacts Assessment

Andrew Schwarz  
aschwarz@water.ca.gov

# 2010 Report

## **“Climate Change Characterization and Analysis in California Water Resources Planning Studies”**

**Abdul Khan and Andrew Schwarz**

**[http://www.water.ca.gov/climatechange/docs/DWR\\_CCCStudy\\_FinalReport\\_Dec23.pdf](http://www.water.ca.gov/climatechange/docs/DWR_CCCStudy_FinalReport_Dec23.pdf)**

	Planning Study Name	Project Analysis/General Study	DWR's Role	Planning Horizon	Spatial Coverage	Climate Analysis Approach	Number of GCMs Considered
1	CWP Update 2009 - B160	General Study	DWR Study	2050	Statewide	Scenario Analysis	6
2	2006 SWP/CVP Impacts Report	General Study	DWR Study	2050 (mid-century).	Central Valley and SWP/CVP service areas.	Scenario Analysis	2
3	2009 SWP/CVP Impacts Report	General Study	DWR Study	2045 (mid-century); 2085 (end of century).	Central Valley and SWP/CVP service areas.	Scenario Analysis	6
4	SWP Delivery Reliability Report 2009	General Study	DWR Study	2029	Central Valley and SWP service areas.	Scenario Analysis	6
5	Management Response Status Report	General Study	DWR Study	2045	Statewide	Scenario Analysis	6
6	DRMS Phase 1 Report	General Study	DWR Study	50-, 100-, and 200-years from the present.	Central Valley and the Delta.	Scenario Analysis w/ monte carlo sim.	13
7	Monterey Plus FEIR 2010	Project Analysis	DWR Study	2020	Central Valley and SWP service areas.	Relative change	2
8	Salton Sea Ecosystem Restoration Program	Project Analysis	DWR Study	2078	Salton Sea area	Scenario Analysis w/ monte carlo	2
9	Oroville Facilities Relicensing	Project Analysis	DWR Study	2058	Central Valley and SWP service areas.	Qualitative approach.	Not applicable.
10	BDCP and DHCCP Operations and Planning	Project Analysis	Participant	2015; 2025; and 2060.	Central Valley, SWP/CVP service areas.	Ensemble informed approach.	16
11	CVP/SWP OCAP BA	Project Analysis	Participant	2025 and 2050.	Central Valley, SWP/CVP service areas.	Scenario Analysis (single scenario)+	16
12	Los Vaqueros Reservoir Expansion EIR/EIS	Project Analysis	Participant	2030	The Delta and the Bay area.	Qualitative Approach	2
13	CVP IRP	Project Analysis	Other Related Efforts	2030, 2060, and 2085.	Central Valley and CVP service areas.	Ensemble informed approach.	16

# DWR Climate Change Approaches

## Qualitative

Conceptual discussion

Los Vaqueros EIR/S

## Relative Change

Based on general information apply a change factor to variables of concern

Monterey Plus PEIR

## Scenario Based

Use selected downscaled GCM simulations

CAT Report 2009  
Water Plan 2009

## Ensemble Approach

Use multiple downscaled GCM simulations grouped into an ensemble(s)

Bay Delta  
Conservation Plan

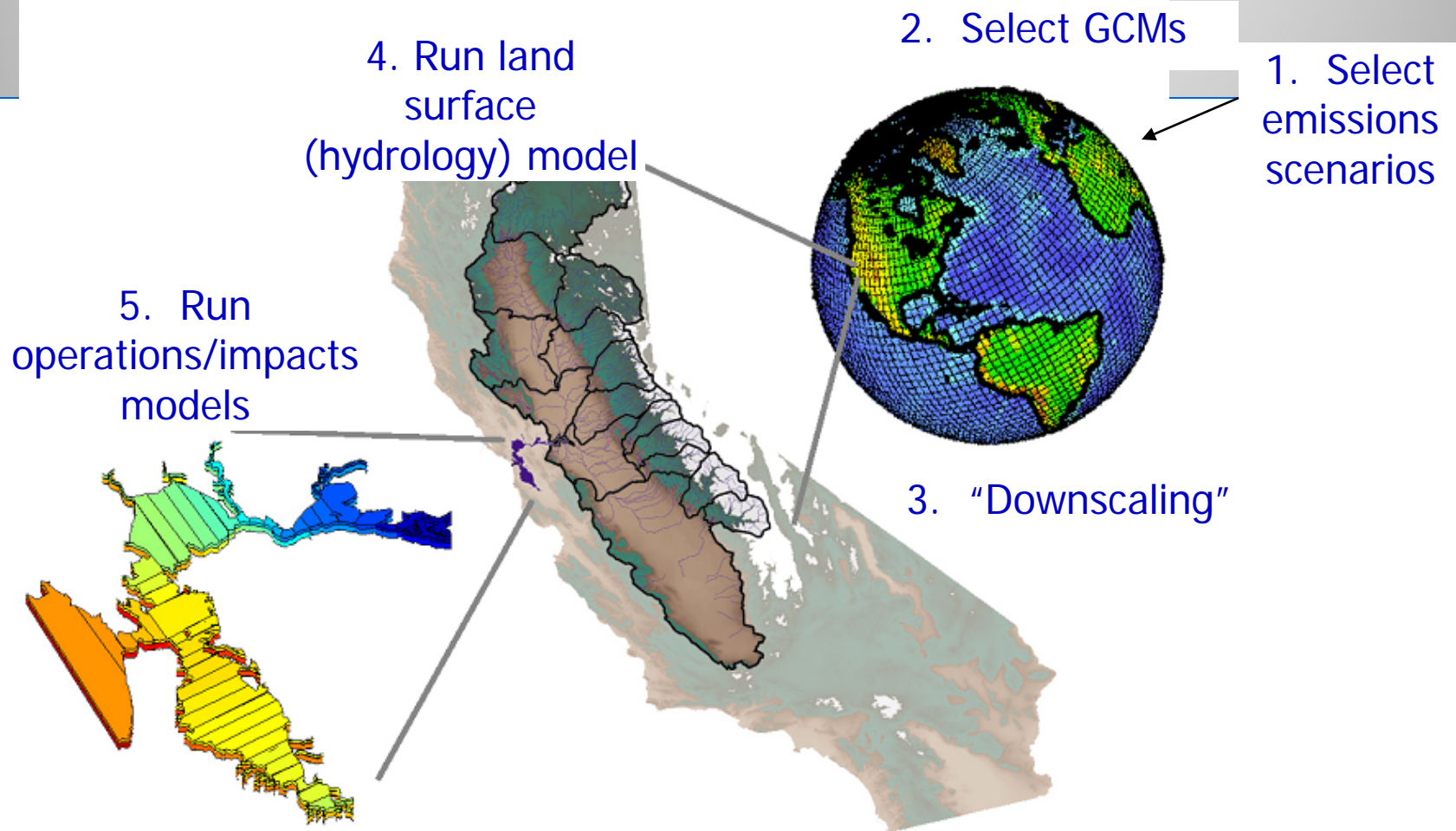
CAT = Climate Action Team  
GCM = Global Climate Model

# DWR Climate Change Analysis Methods

Project	Downscaled GCM/Climate Characterization	Rainfall-Runoff Model	Water Supply Model	Hydrologic Analysis
2006 Climate Action Team (CAT) Report	4 CAT scenarios	VIC	CalSim	Adjusted Historical
2009 Climate Action Team (CAT) Report	12 CAT scenarios	VIC	CalSim	Adjusted Historical
2009 Water Plan	12 CAT scenarios	WEAP (evaluated future water demands under climate change)		Model Generated
Operation Criteria and Plan (OCAP)	4 downscaled GCMs selected from ensemble	VIC	CalSim	Adjusted Historical
Bay-Delta Conservation Plan	5 ensemble informed scenarios	VIC	CalSim	Adjusted Historical
2013 Water Plan	TBD with CCTAG input	WEAP		?



# All Approaches Follow Similar Steps



Maurer, 2009 as Adapted from Cayan and Knowles, SCRIPPS/USGS, 2003



# Secondary Approaches

## **Sensitivity Analysis**

Incrementally change selected variables, e.g. +1 °C, +2 °C, +3°C

**CAT Report 2009**

## **Paleoclimate Analysis**

Use paleoclimate data (e.g., tree ring, lake sediments) to inform potential range of uncertainty

**USBR- Colorado River  
Interim Guidelines for  
Lower Basin Shortages and  
Lakes Powell and Mead**

# Findings

## General:

- A range of approaches used
- Approaches reveal an evolution in sophistication
- More advanced methods for longer planning horizon & larger spatial scales
- Trend: to use more quantitative & analytical approaches

# Findings

## Use of Global Climate Model Data:

- Reliance on data from 112 downscaled DOI/LLNL dataset
- Entire DOI/LNLL data set or a subset used
- GCM projections are used both directly & indirectly
- Regional downscaling of data mostly by BCSD
- Primary climate variables used are: temperature, precipitation, and humidity

# DOI/LLNL Archive

[http://gdo-dcp.ucllnl.org/downscaled\\_cmip3\\_projections/](http://gdo-dcp.ucllnl.org/downscaled_cmip3_projections/)

## ➤ Downscaling Method

- Bias Correction Spatial Downscaling

## ➤ 112 total projections

- 3 Emissions (B1, A1b, A2)
- 16 GCMs
- Multiple “runs” per Emission-GCM combo

## ➤ Variables...

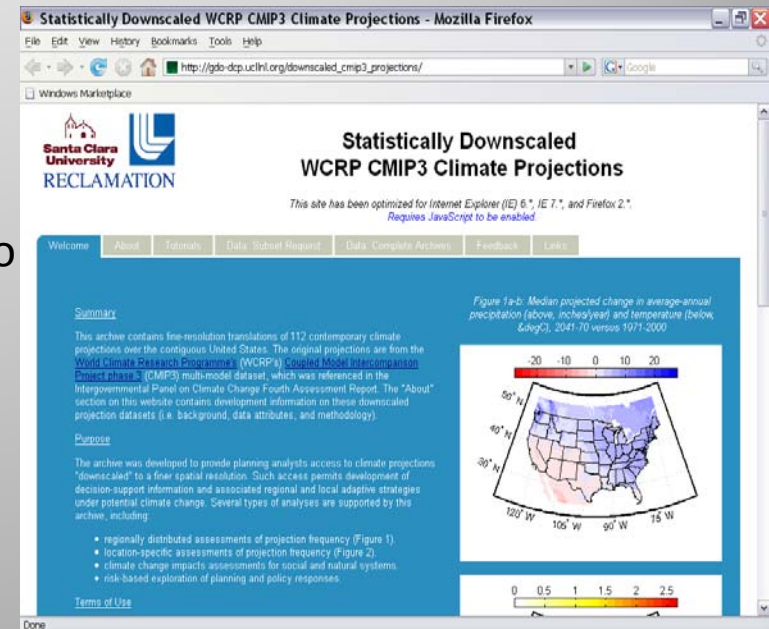
- surface T and P only

## ➤ Coverage

- 1950-2099
- lower 48 states

## ➤ Resolution

- monthly, ~12km



# Findings

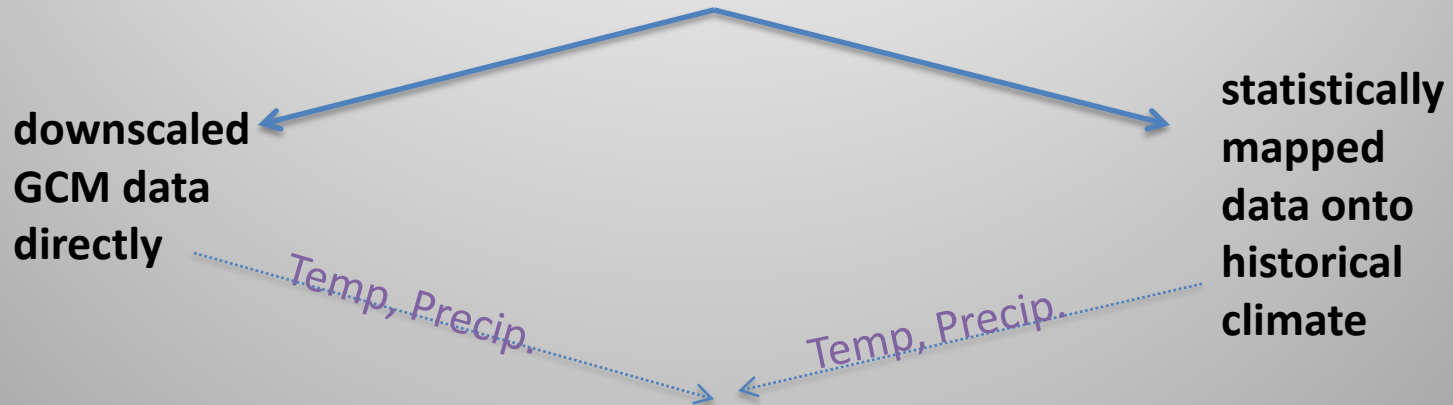
## Planning Horizon:

- Studies reviewed: 15 - 70 years
- Studies with planning horizon greater than 15 years incorporates climate change analysis



# Findings: Analytical Differences

## Characterization of Climate Variability:



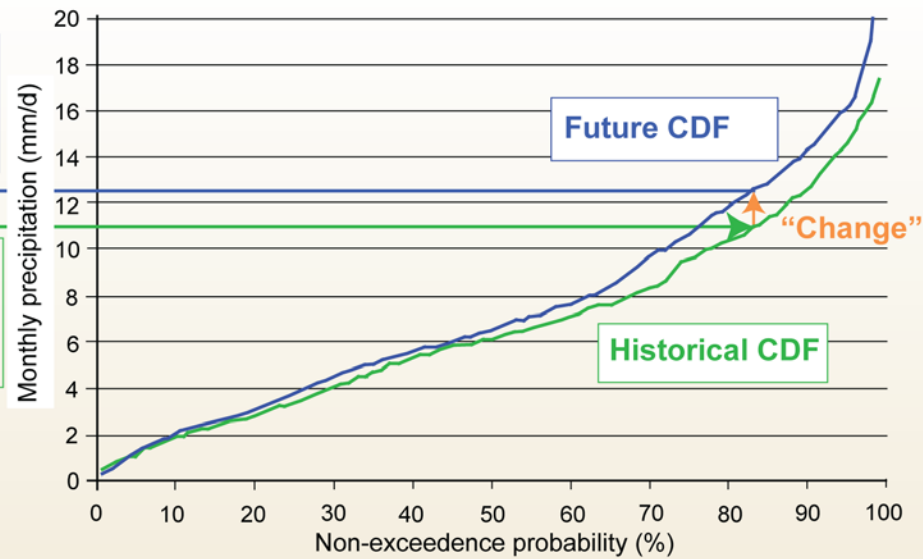
## Simulation of Future Hydrology:



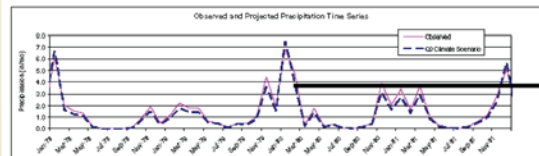


Projected monthly  
time series  
1916-2003

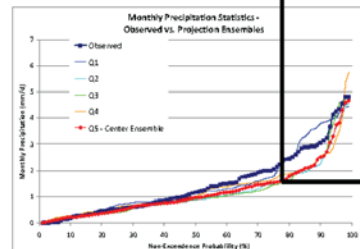
Historical monthly  
time series  
1916-2003



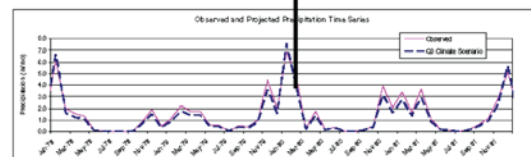
(a) Monthly climate data statistics--historical vs. future



Observed T & P time series



Climate change quantile map



Adjusted  
historical T&P  
time series

(b) Temperature and precipitation time series development

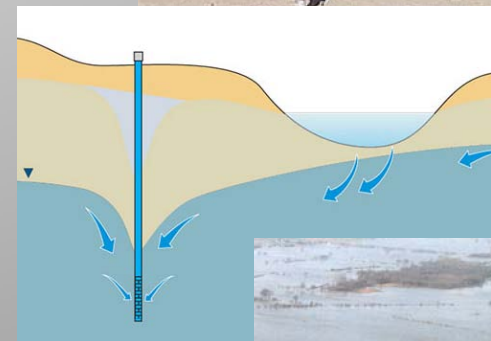
# Sea Level Rise:

- Not considered in several studies
- 1-foot sea level rise assumption for studies with a planning horizon: 2030 to 2050
- 2-feet sea level rise assumption for studies with a planning horizon: 2085 or longer
- Most estimates based on Rahmstorf ( 2007)



# Data Gaps & Needs Assessment

- No assessment of drought conditions that are more extreme than hydrologic records
- No analysis of groundwater impacts
- No analysis of surface water-groundwater interaction
- No analysis of flood protection projects



## **The Upshot:**

- Multiple uses/Multiple approaches
- Different analytical methods
- Lack of consistency
- Variable quality

**Here's where you come in!**

# **We Are Looking For:**

## **1<sup>st</sup> Priority**

### **Detailed recommendations on:**

- climate scenarios appropriate for DWR's planning activities.
- whether climate model outputs should be adjusted with historical data.
- whether hydrology model projections should be adjusted with historical data

# DWR Climate Change Analysis Methods

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# DWR Planning Studies

General Planning  
Studies

(high level, informational)



Project Level  
Studies

(detailed, decision documents)

# **We Are Looking For:**

## **2<sup>nd</sup> Priority**

- Extreme climate change scenarios that represent very challenging scenarios of potential climate changes (Stress-test)
- Interim guidance on projecting and modeling extreme weather events that cause flooding.

# Looking Forward



- DWR has an internal workgroup developing guidance on the use of climate change simulations and analytical approaches
  - Internal guidance
  - Web portal development to share analysis and data sets